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Energy Performance Certificate Classifications Across Shifting Frameworks

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Abstract

Large amounts of valuable data are being collected in the energy performance certificate (EPC) schemes. These data offer a huge potential, in terms of enabling researches to study energy demand in buildings and related causalities. However, revisions of the national schemes and calculation methods necessitate a standardization of the results from the various schemes.

The primary focus of this research is on checking the consistency of converting labels with a given classification from an old scheme directly into that of a newer scheme. Furthermore, a general check is carried out, to review the consistency within each scheme, since the collected data are handled by several stakeholders which use different calculation tools.

In the study, several instances were found, where a simple conversion of a building's energy label classification did not agree with the classification calculated anew, according to the present scheme. The number of inconsistent records was found to vary from scheme to scheme; most of the inconsistent classifications were found in the early schemes however. Fortunately, most information is stored at a disaggregated level, which means that classifications can easily be recalculated. In addition to the inconsistent EPC classifications, a number of corrupt records were observed, in which the energy frame did not seem to agree with the calculated energy demand for heating and electricity.

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Energy performance certificate classifications cannot simply be converted from an old scheme into the present scheme, since calculation preconditions are modified from time to time. However, energy performance certificate classifications from previous schemes can easily be converted to match the present scheme, by recalculating the classification. Therefore, data should be collected

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and stored as disaggregated as possible. This way inconsistent and corrupt data can easily be detected and accounted for. Additionally, additional quality assurance checks could be implemented in the EPC software, as well as when loading the data into a concerted database, to improve the confidence in the data.

1. Introduction

Energy performance certificates (EPCs) have been issued in Denmark since 1997. The current EPC scheme has been operative since 2006 as a result of the Danish implementation of the European Energy Performance of Buildings Directive (2002/91/EC) [1]. All data from this scheme have been stored centrally by the Danish Energy Agency.

The current EPC scheme has been revised five times, since the introduction in 2006 [2]. In each revision the EPC classifications, as well as some of the corresponding energy demand thresholds, have been modified. This necessitates a conversion of the EPC classifications, in order to make them comparable across schemes. Additionally, the energy demand calculation framework has been revised several times, e.g. the amount of locally produced electricity that can be deducted from the calculated energy demand as described in SBi Direction 213 [3].

The primary energy demand, used for issuing EPC in Denmark, uses a concerted calculation core according to [3]. Building component data are collected in several different EPC tools, which make use of this concerted calculation core, from where the EPC is issued. After the EPC has been issued, all corresponding data are uploaded to a central register (see Fig. 1). From this central register, all data can be imported into a joint database.

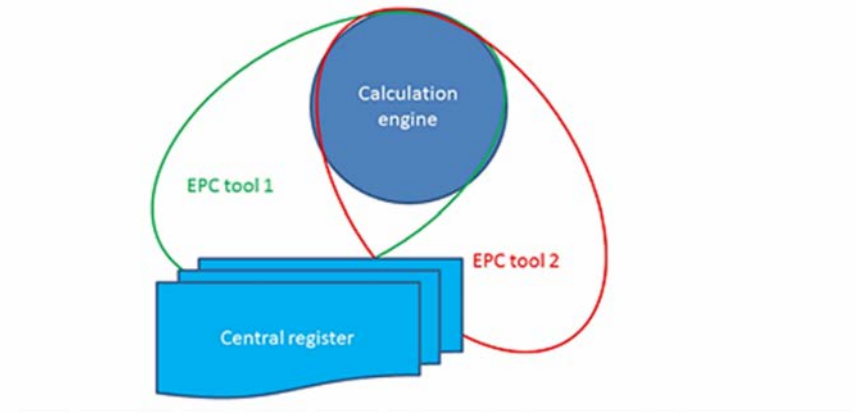

Fig. 1. Relations between the central calculation core, the EPS tools and the central register in the Danish EPC scheme.

The use of different user interfaces, in terms of the different EPC tools, as well as the import of the data to a national database, pose a potential risk of introducing faulty data. This article considers some of the aspects related to the validity and reliability of the EPC data, including conversion of EPC classifications.

2. Conversion of EPC classifications

In Denmark, conversion tables have been developed, in order to make classifications issued in previous versions of the EPC schemes comparable to those issued in other versions. The conversion table for residential buildings, which is provided by the Danish Energy Agency, is shown below [4].

Not only the EPC classifications have been modified, so has the primary energy demand threshold limit. Hence, it was decided to recalculate the EPC classifications according to the present scheme, to check the validity of such a 1:1 conversion. Therefore, this paper does not offer a full exposition of all discrepancies, but is rather an assessment of the validity of using the conversion table, shown in Table 1, for 1:1 conversion of EPC classifications. Additionally, the paper gives some recommendations for checking the validity of the data before importing it to central database.

Table 1. EPC classification conversion table for residential buildings.

2006 scale	2008V1 scale	2008V2 Scale	2012 Scale	Threshold limit 2008-2012 [kWh/m²/yr.]	2013 Scale	Threshold limit 2013- [kWh/m²/yr]
-	-	-	-	-	A2020	20
-	-	-	A1	≤ 35,0 + 1100/A	A2015	≤ 30,0 + 1000/A
A1,A2	A	A1,A2	A2	≤ 50 + 1600/A	A2010	≤ 52,5 + 1650/A
B1	B	B	B	≤ 70,0 + 2200/A	B	≤ 70,0 + 2200/A
B2,C1	C	C	C	≤ 110 + 3200/A	C	≤ 110 + 3200/A
C2,D1	D	D	D	≤ 150 + 4200/A	D	≤ 150 + 4200/A
D2,E1	E	E	E	≤ 190 + 5200/A	E	≤ 190 + 5200/A
E2,F1	F	F	F	≤ 240 + 6500/A	F	≤ 240 + 6500/A
F2,G1,G2	G	G	G	> 240 + 6500/A	G	> 240 + 6500/A

2.1. EPC classification in the present Danish scheme

In Denmark, energy performance certifications are issued on the basis of minimum energy performances, which is given by a calculated primary energy demand. The primary energy demand threshold limits, as well as which energy demands to include in the calculation, depends on whether the building is classified as a residential building, a commercial building, or a combined building (mixed use). In the present Danish EPC scheme, buildings are considered to belong solely to the primary use category, if at least 80 percent of the total heated gross floor area is used for the primary purpose (i.e. either residential or commercial). In case the primary use area constitutes less than 80 percent of the total heated gross floor area, or if the secondary use area exceeds 1000 m², then the building is considered to be a combination of the two use categories (mixed use).

The current threshold energy demand limit for each of the two categories is shown in the table below.

Table 2. Threshold primary energy demand in the present Danish EPC scheme.

EPC classification	Threshold (residential buildings) [kWh/m²/yr.]	Threshold (commercial buildings) [kWh/m²/yr.]
A2020	20	25
A2015	≤ 30.0 + 1000/A	≤ 41.0 + 1000/A
A2010	≤ 52.5 + 1650/A	≤ 71.3 + 1650/A
B	≤ 70.0 + 2200/A	≤ 95.0 + 2200/A
C	≤ 110 + 3200/A	≤ 135 + 3200/A
D	≤ 150 + 4200/A	≤ 175 + 4200/A
E	≤ 190 + 5200/A	≤ 215 + 5200/A
F	≤ 240 + 6500/A	≤ 265 + 6500/A
G	> 240 + 6500/A	> 265 + 6500/A

In buildings which fall into the category of mixed use, each part is considered separately and a weighted average is used to issue one EPC classification to the building.

The reason for the distinction between residential and commercial buildings is that electricity for lighting is only considered in the calculated primary energy demand in commercial buildings. In residential buildings, only electricity for HVAC systems is considered in the calculated primary energy demand. These two building types are the only ones being used in the Danish EPC scheme. After categorizing the building, the energy demand, and hence the EPC classification, can be determined.

2.2. Recalculating EPC classifications

In order to re-determine the classification of the existing EPC's, all records were first imported into a common database. These records contain all the information necessary to recalculate the primary energy demand, including the total primary energy demand. Thus, the EPC classification was re-determined solely on the information in the existing EPC's, in particular the total primary energy demand, assuming that these data were correct.

3. Results and Discussions

Based on the calculated primary energy demand, from the established EPC database, the converted original EPC classifications were compared to the re-determined classification. The converted EPC classifications are compared to the re-classified EPC classifications in Table 3 below.

Table 3. EPC classification - converted vs. re-calculated.

		EPC classification (re-calculated)								
		A2020	**A2015**	**A2010**	**B**	**C**	**D**	**E**	**F**	**G**
EPC classification (converted)	**A2020**	1660	46	6	0	4	1	2	2	4
	A2015	646	2741	304	21	14	5	4	3	6
	A2010	681	232	11651	1270	438	94	46	44	31
	B	1189	26	1154	14219	9822	425	107	44	30
	C	25	13	386	1335	62699	15979	844	303	97
	D	10	6	236	882	2533	76107	16256	1314	476
	E	12	4	201	524	374	3470	49386	10087	1445
	F	13	5	243	321	101	405	2811	29818	6995
	G	18	4	357	309	50	138	322	1969	32649

The numbers on the diagonal indicate the number of buildings that would obtain the same EPC classification by use of the conversion scheme in Table 1, as if it is calculated anew. Numbers below the diagonal indicate the number of buildings, that would obtain a "better" EPC classification when calculated according to the present scheme, than if converted, and conversely for the numbers above the diagonal.

Table 4. Consistency across schemes.

Scheme	**Agreement**	**Disagreement**
2013 (present)	93.3 %	6.7 %
2012	94.7 %	5.3 %
2008V2	58.3 %	41.7 %
2008V1	52.6 %	47.4 %
2006	57.9 %	42.1 %

In the Table 3, 76 % of all EPC's would attain the same classification by conversion, as by recalculation (i.e. they are located on the diagonal). However, these numbers include EPC's from all scheme versions, i.e. also the most recent one. Therefore, the consistency of the simple conversion was checked for each scheme. Results are given in Table 4 below.

One might expect a complete compliance (i.e. 100 percent agreement) in the present scheme; however, flawed records were detected, which may explain the observed discrepancies. The origins of these flaws are considered to be beyond the scope of this text and will therefore not be considered further.

There was a good agreement between the converted- and the recalculated EPC classifications in the '2012' scheme. In schemes prior to the '2012' scheme (i.e. '2008V2', '2008V1' and '2006'), large discrepancies were observed. Whether these discrepancies arise due to changes in the schemes or due to flawed data is difficult to assess without

further assessment; however, it seems plausible that changes made to the scheme contribute to these discrepancies. What should be noticed is that the threshold primary energy demand limit was not modified from the '2008V2' scheme to the '2012' scheme (see Table 1). Therefore, the threshold primary energy demand limit was insufficient, to explain the observed deviations on its own. Therefore, modifications made to the schemes seem to have an impact on which EPC classification a building would obtain. These modifications include when buildings are considered to be of mixed use, and the amount of electricity produced locally, that can be included in the calculated energy demand.

4. Recommendations

Unfortunately, instances of flawed records were observed. Whether these flaws originate from the EPC software or from loading the results into the database has not been investigated. Therefore, it is recommended to implement quality assurance checks, in order to reduce the amount of faulty data.

One such consistency check could be implemented by posing certain restrictions on the different input parameters in the EPC software, e.g. maximum U-values, etc. Such restrictions, or recommendations, should be posed in the different EPC software, as it is very difficult to evaluate the validity of the data later in the process.

An additional consistency check could be implemented, when importing the data from the central register into the joint database. Checking that the EPC classification is consistent with the calculated primary energy demand is just one possibility among many.

5. Conclusions

Since the introduction of the EPC scheme in Denmark, the scheme has been modified several times. Therefore, it may be necessary to convert EPC classifications, in order to compare classifications across schemes.

In making such conversions, it is insufficient to consider only the threshold energy demand limit, since various other modifications may also impact on the EPC classification a building attains. Therefore, data should be collected and stored, at a disaggregated level, which allows for recalculation of the EPC classification of building classified in previous schemes.

The comparison of data across schemes could be facilitated, by keeping a record of which changes that are made to each scheme along with the exact time of the change. Furthermore, flawed data are inevitable, for which reason a quality assurance check should be implemented, when loading the individual data into a concerted database.

Acknowledgements

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